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With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

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HYBRIDS OF PRIMROSE AND COWSLIP.

By E. G. HIGHFIELD, B.Sc.

In a district where both primrose and cowslip are plentiful it is quite a common thing to meet with intermediate forms possessing, in varying degrees, the character of both. These plants are commonly called "oxlips," but they must not be confused with true oxlip (*Primula elatior*), if such exists as a fixed species. There is no fixity about these variant forms. Every gradation of intermediate characters between the two species may be found, from a primrose-like flower borne on a single stalk, but showing cowslip parentage in a slightly deeper tinge of yellow, to umbel-bearing flowers, varying in colour and form through every possible gradation of the two characters.

The hybrid origin of these flowers is probable from many considerations. There is little structural difference between the flowers of primrose and cowslip, and there is every likelihood that occasionally pollen should be conveyed from one to the other by insects. It is noticeable too that the intermediate forms are very commonly met with in a belt between a primrose and a cowslip habitat.

In order, however, to put the matter to a definite test, and also by way of providing an interesting experiment on the efficacy of the cross-pollination device of these flowers, I made plans to carry out a somewhat lengthy investigation in the spring of 1913.

Before entering upon the details of the experiment, a brief description of the cross-pollination device of the flowers will be necessary.

The most casual observer will be aware that there are two forms of primrose flower, commonly known as pin-eyed and thrum-eyed, or long-styled and short-styled. In Figure 108, A represents a section of the long-styled flower, in which the stigma appears at a higher level than the stamens. B is a section of a short-styled flower in which the stamens are above the stigma. It will be seen that the stamens of the one and the stigma of the other are at the same level relative to the corolla tube, so that an insect, visiting first one kind of flower and then the other, would carry pollen from the stamens of the first and place it on the stigma of the second; whereas, if the insect went from one flower to another of the same type, the pollen would fail to come in contact with the stigma. We have, then, here a most definite contrivance for securing cross-pollination, and preventing self-pollination, or even pollination between two similar individuals.

The flowers on a plant are invariably all of one type, so, if the device succeeds in its purpose, a plant can only set its seed if it receives pollen from some other plant.

The efficiency of the device would seem to be further assured by certain marked structural differences between the pollen and the stigmatic surfaces of the two types. The pollen of the long-styled flower is rather small and round; whilst the stigmatic surface has large papillae. The pollen of the short-styled flower is larger and more

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oval than that of the first, and the stigmatic surface consists of close-grained small papillae. Thus it would seem that the large oval grains of the B type are specially adapted to fit the larger spaces between the papillae of the stigma of the A type, and would possibly fail to germinate on the small papillae; whilst the smaller grains of the A type may be most effective on the small papillae of the B stigma.

Precisely the same dimorphism of flowers exists in cowslip, and since there is little difference in the length of the style and corolla tube in the two species there is every reason to believe that hybridisation might occur naturally.

It does not seem to be very definitely known what insects are mainly responsible for the pollination of the primrose. The honey-bee does not visit it, owing no doubt to the corolla tube being too long for its tongue. The bumble-bee is a somewhat random visitor. Probably pollination is effected by sawflies and butterflies by day, and by moths at night; since the primrose does not close at night, and its pale colour renders it conspicuous. It is quite common to find small black thrips in the corolla tube, but these, if they do anything at all, would only effect self-pollination, since they do not go from flower to flower.

I have made observations after the flowering season of a large number of wild primrose plants, and have found that only a small proportion of the flowers on a plant, rarely exceeding half, sets its capsules. This observation would appear to confirm the success of the cross-pollination device, at all events so far as the exclusion of self-pollination is concerned. When a flower has been pollinated, it rapidly fades, and the stalk curves so that the developing capsule is brought down to the ground and hidden under the leaves. Flowers which have not been pollinated remain upright and merely wither away.

In my experiment I selected early in April, 1913, wild plants of primrose and cowslip of each type. The plants were dug up, with an ample amount of turf, and planted in boxes and labelled according to their type thus :—

A. Primrose, long-styled.
B. Primrose, short-styled.
C. Cowslip, long-styled.
D. Cowslip, short-styled.

A special pollination frame was made for the experiment, consisting of an ordinary cold frame with close-fitting glazed top and sides, ventilated with windows of perforated zinc. The frame was thus proof against all larger winged insects when the top light was closed. The flowers originally on the plants were removed, and the plants were kept in the closed frame during the whole flowering period, and only removed when artificial crossing was being effected.

The pollen was conveyed by a fine sable paint-brush slightly moistened. It was easy to carry pollen from stamens of short-styled to stigmas of long-styled flowers without risking self-pollination; but in order to reach the stigmas of the short-styled flower it was necesssary first to remove the ring of stamens with forceps. Immediately after pollination a small zinc label, bearing the identification letters of the cross, was attached to the flower-stalk with wire, the letter standing first indicating the flower from which the pollen was taken; thus A×B=pollen from long-styled primrose on the stigma of short-styled primrose.

The fact that both primrose and cowslip are unable to set seed without an external agency was abundantly demonstrated. With but two doubtful exceptions, all the uncrossed flowers failed to set; whereas all flowers crossed, whether as hybrids or by self-pollination, set their capsules, although the seed did not in all cases mature.

The following is a record taken in June, showing the number of flowers which had been crossed, and which were apparently setting seed :—

3 A Plants : 14 flowers.
9 crossed ; all set.
5 uncrossed ; none set.

3 B Plants : 33 flowers.
7 crossed ; all set.
26 uncrossed ; none set.

5 C Plants : 16 umbels ; very numerous flowers.
39 flowers crossed ; all set.

The uncrossed flowers all failed with the exception of two, which might have been crossed accidentally, but which were not labelled.

3 D Plants : 6 umbels.
9 flowers crossed ; all set.
Uncrossed flowers set no seed.

The seed was gathered at intervals when the capsules dehisced, and the following is a record of the crosses from which apparently mature capsules were collected :—

A Plants : B×A, 4 capsules.
A×A, 1 capsule.
D×A, 3 capsules.
Total, 8 out of 9 flowers crossed (C×A failed).

B Plants : A×B, 1 capsule.
C×B, 4 capsules (very large seed).
Total, 5 out of 7 flowers crossed (B×B failed, and unfortunately there is no record of a D×B cross).

C Plants : A×C, 2 capsules, but seed withered.
B×C, 18 capsules.
D×C, 6 capsules.
C×C, 5 flowers crossed, but uncertain.
Total, 26 capsules from 39 flowers crossed.

D Plants : C×D, 6 capsules.
A×D, 2 capsules.
Total, 8 from 9 flowers crossed (no record of D×D or B×D).

FIGURE 104. Types of B × C flowers.

FIGURE 105. Types of A × D flowers.

FIGURE 106. B × C Hybrids.

FIGURE 107. A × D Hybrids.

HYBRIDS OF PRIMROSE AND COWSLIP.

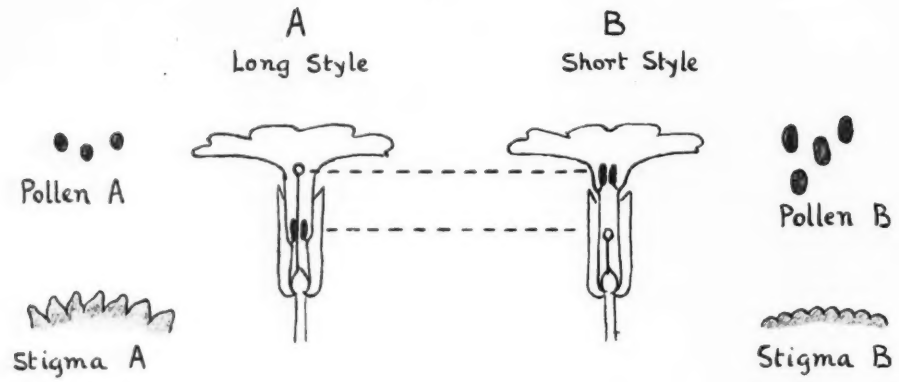

FIGURE 108.

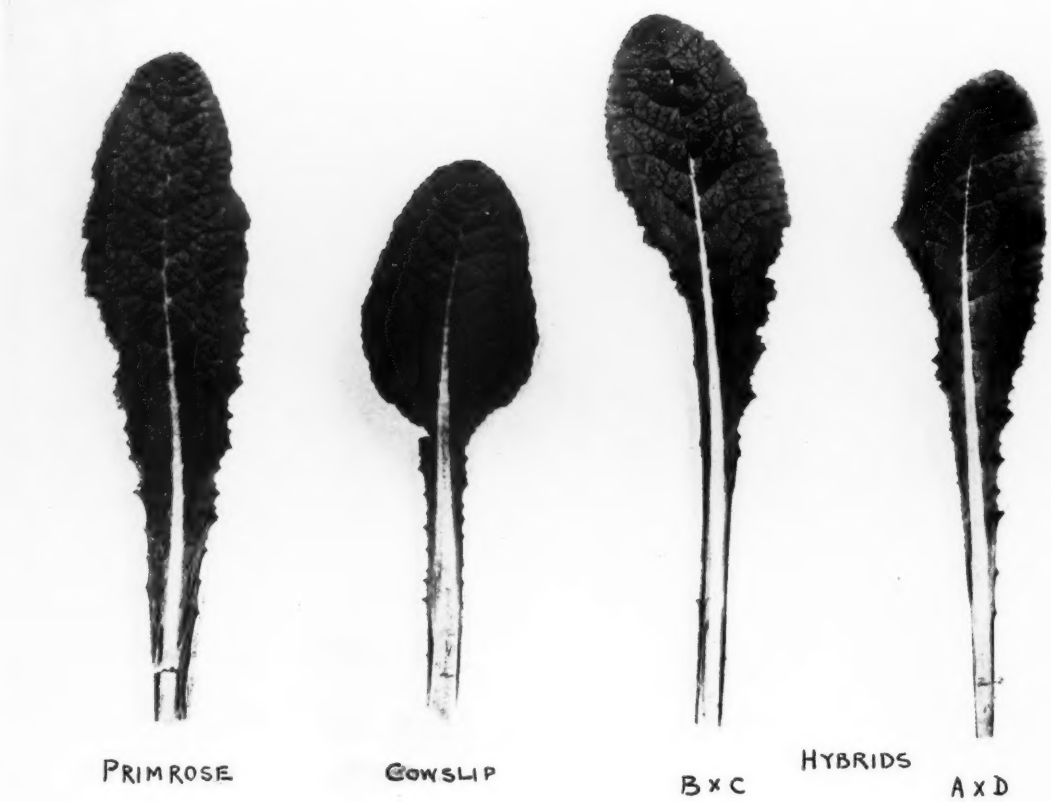

FIGURE 109.

The flowers chosen for crossing were those which had recently opened, and which seemed to be in the best condition. It is to be regretted that a more definite system was not adopted, and that an equal number of crosses of each kind was not attempted. Owing to failure in this respect, the above record does not give conclusive evidence of the fertility, or otherwise, of all kinds of crosses.

GERMINATION.

The seed was sown in November, 1913, each cross in a separate box. A light, sandy soil was used. The boxes were kept in a cold frame during the winter, and watered only by rain.

Germination began to be apparent in March, 1914. The normal crosses of B×A and A×B primrose and D×C and C×D cowslip were the first to appear, and of these very dense crops were produced. The hybrids were slower in appearing, and only B×C and A×D were raised (A×C, D×A, and C×B failed to germinate). Of the self-pollinations, A×A and C×C were raised.

In May, 1914, selected plants were pricked out in a frame, each kind being placed in a separate partition, and in this state they were left to mature.

In the spring of 1915 all the plants were in very healthy condition, and they bloomed very freely during March, April, and May.

Photographs of the massed flowers were taken on May 9th, 1915. Figure 106 shows the left-hand half of the bed; B×C hybrids are in the middle, with B×A primrose in front and A×B primrose behind. Figure 107 shows the right-hand half, with A×D hybrids in the middle, D×C cowslip in front, and C×D cowslip behind. The small number of self-fertilised plants were in the middle between the two hybrid groups.

Normal crosses, both of primrose and cowslip, namely, A×B, B×A, C×D, D×C, were absolutely true to type, and it was impossible to distinguish in any way between the two groups of each kind. Long-styled and short-styled plants were about equal in number.

Of the two self-pollinated groups A×A primrose were all long-styled, and C×C cowslip were all long-styled.

Of the hybrids the B×C group showed much variation. Figure 104 shows typical forms of flowers. Some flowers were single, shaped like a primrose, but slightly smaller and of much deeper yellow. The plants producing these single flowers also produced umbels. The flowers on the umbels varied in form between primrose and cowslip, but all showed a deeper yellow than the primrose. Some flowers were almost indistinguishable from cowslip in form, but slightly paler in colour, and showed distinct hybrid characters in the leaves. The group as a whole showed decided dominance of cowslip characters.

In the A×D group there was less variation; all the flowers were borne in umbels. They were all shaped like primrose, but slightly smaller. The colour was pale, but the centres were deeply orange-tinted. Types of flowers are shown in Figure 105. The primrose characters appear to dominate in this group.

In every plant the hybrid character was shown very distinctly in the leaves. There is a marked difference, both in shape and colour, between primrose and cowslip leaves, and the differences are merged almost equally in the leaves of the hybrids. Figure 109 shows typical leaves of each kind.

During the flowering season the frame was left open, so that the flowers were visted by insects. Bumble-bees were frequent visitors to the hybrids. All plants set seed abundantly.

A few of the hybrid flowers were intercrossed and bagged up, and from these apparently fertile capsules have been obtained and the seed sown; but the results, so far as the nature of the flowers obtained, will not be apparent until 1917.

The experiment has demonstrated that hybridisation is possible between the two species, and that a great variety of intermediate forms similar to those met with in nature can be produced by artificial crossing. That success was only obtained with two of the possible hybrid crosses does not necessarily imply that the others are not fertile. Apparently good seed, both of C×B and D×A, was obtained, but it failed to germinate. Flower-growers will know that primula seed of all kinds is slow in germination, and is not a very certain crop.

The experiment also shows very conclusively that the flowers are absolutely dependent upon insect pollination for the setting of seed. Self-pollination, or pollination between the same types, may in some cases happen as the result of insect visits, and fertile seed may result. It is somewhat significant that the only successful self-pollinations were with long-styled plants, that is, the small-grained pollen could germinate on the large-grained stigma. It must, however, be admitted that in the experiment there was not a sufficient number of self-pollinated crosses taken to give definite evidence of the failure of B×B and D×D crosses. There could be no question as to the superior fecundity of the normal crosses. In all these cases, both with primrose and cowslip, the capsules were crowded with seed, and on sowing, the seeds germinated freely, producing very dense crops; whereas of the hybrids and self-pollination crosses only a comparatively small number of plants was raised.

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THE FACE OF THE SKY FOR JULY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 29.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Mars. R.A.	Mars. Dec.	Jupiter. R.A.	Jupiter. Dec.	Uranus. R.A.	Uranus. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°
July 4	6 52·8	N. 22·9	9 50·5	N. 10·5	5 21·7	N. 20·8	6 46·9	N. 19·2	11 21·2	N. 5·0	1 58·4	N. 10·8	21 26·9	S. 15·8
„ 9	7 13·3	22·4	13 41·1	S. 16·2	5 51·4	22·1	6 34·0	18·5	11 31·5	3·8	2 1·1	11·0	21 26·3	15·8
„ 14	7 33·7	21·7	18 51·8	S. 24·5	6 28·2	23·0	6 23·3	17·9	11 42·0	2·5	2 3·6	11·2	21 25·7	15·9
„ 19	7 53·9	20·9	23 37·0	N. 2·3	7 10·8	23·1	6 16·3	17·5	11 52·7	1·3	2 5·9	11·4	21 25·0	16·0
„ 24	8 13·8	19·9	3 47·9	N. 24·6	7 56·0	22·2	6 13·5	17·4	12 3·4	N. 0·1	2 8·0	11·6	21 24·3	16·0
„ 29	8 33·5	N. 18·8	8 6·8	N. 20·2	8 40·4	N 20·1	6 14·7	N. 17·4	12 14·4	S. 1·2	2 9·7	N. 11·7	21 23·5	S. 16·1

TABLE 30.

Date.	Greenwich Noon. Sun. P	Sun. B	Sun. L	Jupiter.	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2	Midnight. Moon.	Moon. P
	°	°	°		°	°	°	°	h. m.	h. m.		°
July 4 ...	−1·2	+3·3	31·7	July 3 ...	−21·5	+3·0	70·3	178·9	10 4 *m*	7 3 *m*	July 4	+19·5
„ 9 ...	+1·0	3·9	325·6	„ 10 ...	21·3	3·0	95·2	150·3	9 23 *m*	7 50 *m*	„ 9	+20·0
„ 14 ...	3·3	4·4	259·4	„ 17 ...	21·1	3·1	120·1	121·9	8 42 *m*	8 37 *m*	„ 14	− 6·8
„ 19 ...	5·5	4·8	193·2	„ 24 ...	20·9	3·1	145·2	93·6	8 1 *m*	9 24 *m*	„ 19	−22·9
„ 24 ...	7·7	5·3	127·1	„ 31 ...	−20·8	+3·1	170·4	65·4	7 19 *m*	0 15 *m*	„ 24	−11·2
„ 29 ...	+9·8	+5·7	61·0								„ 29	+12·5

P is the position angle of the North end of the body's axis measured eastward from the North point of the disc. B, L are the helio-(planeto-) graphical latitude and longitude of the centre of the disc. T is the time of transit of the zero meridian across the centre of the disc. In the case of Jupiter, System I refers to the rapidly rotating equatorial zone; System II to the temperate zones which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc, apply to T_1 T_2 multiples of $9^h\ 50^m{\cdot}6$, $9^h\ 55^m{\cdot}8$ respectively.

The data for the Moon in Table 30 are given for Greenwich midnight, *i.e.*, the midnight at the end of the given day. Those for the planets were given for midnight last year, but are now given for Noon.

The letters *m*, *e* stand for morning, evening. The day is taken as beginning at midnight.

THE SUN has begun to move Southward. It is at its greatest distance from the Earth (about 94,600,000 miles) at 6^h *m* on July 3rd. Its semi-diameter increases from 15′ 45″ to 15′ 47″. Sunrise changes from $3^h\ 49^m$ to $4^h\ 24^m$; sunset from $8^h\ 18^m$ to $7^h\ 49^m$. There is now considerable solar activity, and a constant watch should be kept on the disc.

MERCURY is a morning star till the 28th, when it passes Superior Conjunction and becomes an evening star; it is fairly well placed for Northern observers. It reached elongation 22° West of Sun on June 30th. Semi-diameter diminishes from 4″ to 2½″. Illumination, one-third at beginning of month, full at end.

VENUS is an evening star on 1st, approaching Inferior Conjunction, which is reached on 3rd at 8^h *e*. The semi-diameter diminishes from 30″ (its maximum value) to 21½″. A series of good micrometer measures of the distance between the horns on several days near Inferior Conjunction would be of value. Illumination almost zero at conjunction, $\frac{1}{6}$ at end of month.

THE MOON.—First quarter $8^d\ 11^h\ 55^m$ *m*; Full $15^d\ 4^h\ 40^m$ *m*; Last quarter $21^d\ 11^h\ 33^m$ *e*. New $30^d\ 2^h\ 15^m$ *m*. Perigee 14^d Midnight. Apogee $28^d\ 7^h$ *m*. Semi-diameter 16′ 45″, 14′ 44″ respectively. Maximum librations 8^d 8° E., 9^d 7° N., 21^d 8° W., 22^d 7° S. The letters indicate the region of the Moon's limb brought into view by libration. E., W. are with reference to our sky, not as they would appear to an observer on the Moon. (See Table 33.) Attention is called to the fact that Full Moon occurs when the Moon is unusually near the Earth.

PARTIAL ECLIPSE OF THE MOON, MORNING OF JULY 15TH.—First contact with the shadow $3^h\ 19^m$ *m*, the Penumbra having been entered an hour earlier. The beginning of the eclipse is visible in London, the Sun rising and Moon setting at $4^h\ 2^m$. Greatest eclipse at $4^h\ 46^m$, when $\frac{1}{8}$ of the Moon (the southern part of the disc) remains uneclipsed. Last contact with shadow $6^h\ 12^m$. The eclipse is well seen in America.

ANNULAR ECLIPSE OF THE SUN, JULY 30TH, VISIBLE IN AUSTRALIA.—Details of this eclipse were given last month.

MARS is advancing, with increased speed, in Leo, and afterwards in Virgo. It will be low in the West and badly placed for observation. Semi-diameter 2½″. Defect of illumination 0″·5. The North Pole of the planet is now turned towards the Earth and the Sun. The planet is in the part of its orbit that corresponds with the second half of July on Earth. The summer solstice of Mars' Northern Hemisphere was passed on May 6th. On August 4th the Earth and Mars will be in exactly corresponding parts of their year of seasons, each having travelled 132° in longitude from their position at the time of their vernal equinox.

JUPITER is a morning star in Aries. 12° South of Alpha

on 12th. Equatorial diameter 39″, Polar 37″. Defect of illumination 0″·4.

Configuration of satellites at $1^h\ 30^m$ *m* for an inverting telescope.

JUPITER'S SATELLITES.

Day.	West.	East.	Day.	West.	East.
July 1	43 ○	1 2●	July 17	34 ○	21
,, 2	431 ○	2	,, 18	4213 ○	
,, 3	432 ○	1	,, 19	4 ○	213
,, 4	421 ○	3●	,, 20	4 ○	23 1●
,, 5	4 ⊙	23	,, 21	421 ○	3
,, 6	4 ○	123	,, 22	423 ○	1
,, 7	241 ○	3	,, 23	31 ○	2
,, 8	32 ○	41	,, 24	34 ○	21
,, 9	31 ○	24	,, 25	231 ○	4
,, 10	3 ⊙	14	,, 26	○	134 2●
,, 11	213 ○	4	,, 27	1 ○	234
,, 12	○	1234	,, 28	2 ⊙	34
,, 13	○	234 1●	,, 29	2 ○	314
,, 14	21 ○	34	,, 30	31 ○	24
,, 15	23 ○	14	,, 31	3 ○	24
,, 16	314 ○	2			

The following satellite phenomena are visible at Greenwich:—$1^d\ 1^h\ 12^m\ 17^s$ *m* II. Ec. D.; $3^d\ 0^h\ 35^m$ *m* II. Tr. E.; $4^d\ 1^h\ 19^m$ *m* III. Oc. D., $2^h\ 24^m\ 40^s$ *m* I. Ec. D., $3^h\ 6^m$ *m* III. Oc. R.; $5^d\ 1^h\ 5^m$ *m* I. Tr. I., $1^h\ 57^m$ *m* I. Sh. E., $3^h\ 14^m$ *m* I. Tr. E.; $6^d\ 0^h\ 24^m$ *m* I. Oc. R.; $8^d\ 3^h\ 47^m\ 53^s$ *m* II. Ec. D.; $10^d\ 0^h\ 36^m$ *m* II. Sh. E., $0^h\ 43^m$ *m* II. Tr. I., $3^h\ 16^m$ *m* II. Tr. E., $11^h\ 50^m\ 29^s$ *e* III. Ec. D.; $11^d\ 1^h\ 57^m\ 9^s$ *m* III. Ec. R.; $12^d\ 1^h\ 41^m$ *m* I. Sh. I., $3^h\ 2^m$ *m* I. Tr. I., $3^h\ 50^m$ *m* I. Sh. E.; $13^d\ 2^h\ 20^m$ *m* I. Oc. R., $11^h\ 39^m$ *e* I. Tr. E.; $17^d\ 0^h\ 35^m$ *m* II. Sh. I., $3^h\ 12^m$ *m* II. Sh. E., $3^h\ 24^m$ *m* II. Tr. I.; $18^d\ 3^h\ 52^m\ 3^s$ *m* III. Ec. D.; $19^d\ 1^h\ 1^m$ *m* II. Oc. R., $3^h\ 35^m$ *m* I. Sh. I.; $20^d\ 0^h\ 41^m\ 16^s$ *m* I. Ec. D., $11^h\ 26^m$ *e* I. Tr. I.; $21^d\ 0^h\ 13^m$ *m* I. Sh. E., $1^h\ 34^m$ *m* I. Tr. E., $11^h\ 55^m$ *e* III. Tr. I.; $22^d\ 1^h\ 25^m$ *m* III. Tr. E.; $24^d\ 3^h\ 12^m$ *m* II. Sh. I.; $26^d\ 0^h\ 53^m\ 17^s$ *m* II. Ec. R., $1^h\ 5^m$ *m* II. Oc. D., $3^h\ 37^m$ *m* II. Oc. R.; $27^d\ 2^h\ 35^m\ 22^s$ *m* I. Ec. D., $11^h\ 57^m$ *e* I. Sh. I.; $28^d\ 1^h\ 20^m$ I. Tr. I., $2^h\ 6^m$ *m* I. Sh. E., $3^h\ 27^m$ *m* I. Tr. E.; $29^d\ 0^h\ 3^m$ *m* III. Sh. E., $0^h\ 39^m$ *m* I. Oc. R., $3^h\ 58^m$ *m* III. Tr. I. Eclipses of the satellites take place low left of the disc, taking the direction of the belts as horizontal.

SATURN is invisible, being in conjunction with Sun on 12th.

URANUS is approaching opposition. It is in Capricornus. New Moon on 16th. Semi-diameter 1″·8.

NEPTUNE is invisible, being in conjunction with Sun on 25th.

GREENWICH TIMES OF MERIDIAN TRANSIT OF CERTAIN BRIGHT STARS.—These are given to facilitate the determination of time by observations with small transit instruments. The times for intermediate days may be obtained by simple interpolation. The Greenwich time of the stars crossing the meridians of other places may be obtained by expressing the longitude of these places in time, diminishing them by $9^s\cdot83$ per hour, and proportionately for fractions of an hour, then applying the result to the tabular time—positively for West longitudes, negatively for East ones. (See Table 31.)

Observers who know Greenwich Time can use the Table to obtain their South Point.

TABLE 31.

Day.	α Coronae. N. Dec. 27° 0′.			Vega. N. Dec. 38° 42′.		
	h.	m.	s.	h.	m.	s.
June 28.....	9	4	41·89 *e*	0	7	9.82**m*
July 8.....	8	25	22·69 *e*	11	27	50·75 *e*
,, 18.....	7	46	3·16 *e*	10	48	31·63 *e*
,, 28.....	7	6	44·19 *e*	10	9	12·47 *e*

* Morning of June 29th.

SUN after clock July 1, $215^s\cdot21$; July 6, $270^s\cdot06$; July 11, $315^s\cdot68$; July 16, $349^s\cdot92$; July 21, $371^s\cdot57$; July 26, $379^s\cdot64$; July 31, $373^s\cdot13$. These are the equations of time for the moment of solar transit at Greenwich.

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
	°	°	
May 30–Aug. ...	333	+ 28	Swift, streaks.
May–July ...	252	− 21	Slow, trains.
June–Aug. ...	310	+ 61	Swift, streaks.
June–Sept. ...	335	+ 57	Swift.
June–July ...	245	+ 64	Swift.
June–Aug. ...	303	+ 24	Swift.
July 6–22 ...	284	− 13	Very slow.
July 15–31 ...	23	+ 43	Swift, streaks.
July 11–23 ...	315	+ 48	Swift, short.
July 22–27 ...	335	+ 51	Swift, streaks.
July–Aug. ...	308	− 12	Slow, long.
July 25–Sep. 15...	48	+ 43	Swift, streaks.
July 28–30 ...	339	− 11	Slow, long.
July–Aug. ...	339	− 27	Slow.
July 8–31 ...	317	+ 31	Swift, white.
July–Aug. ...	280	+ 57	Slow, short.

The Perseids may be seen from July 19, when the radiant is 19° + 50°. The R.A. increases 1° per day, the Dec. 1° in 3 days.

TABLE 32. LONG-PERIOD VARIABLE STARS.

Star.	Right Ascension. h. m. s.	Declination. ° ′	Magnitudes.	Period. d.	Date of Maximum.
R Androm.	0 19 33	+38 6	5·6 to 14·0	411	1916—July 19
R Ceti	2 21 42	− 0 34	7·0 to 13·0	167	,, July 21
R Tauri	4 23 38	+ 9 58	7·4 to 13·8	325	,, July 3
R Virginis	12 34 12	+ 7 27	6·2 to 11·1	145	,, July 16
V Ursae Minoris ...	12 37 10	+74 45	7·5 to 8·7	71	,, July 17
R Boötis...	14 33 27	+27 6	5·9 to 12·2	223	,, July 10
V Cassiopeiae	23 8 1	+59 14	7·1 to 12·6	230	,, July 26

Minima of Algol $4^d\ 2^h\cdot4\ m$, $6^d\ 11^h\cdot2\ e$, $9^d\ 8^h\cdot0\ e$, $24^d\ 3^h\cdot9\ m$, $27^d\ 0^h\cdot7\ m$, $29^d\ 9^h\cdot5\ e$. Period $2^d\ 20^h\ 48^m\cdot9$.

Principal Minima of β Lyrae $5^d\ 1^h\cdot1\ m$, $17^d\ 11^h\cdot2\ e$, $30^d\ 9^h\cdot3\ e$. Period $12^d\ 22^h\cdot1$.

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TABLE 33. Occultations of Stars by the Moon, visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance.		Reäppearance.	
			Time.	Angle from N. to E.	Time.	Angle from N. to E.
1916.			h. m.	°	h. m.	°
July 11 ...	65 B Scorpii	5·5	10 57 *e*	90	0 5 *m**	280
„ 14 ...	49 Sagittarii	5·5	9 31 *e*	69	10 39 *e*	266
„ 16 ...	υ Capricorni	5·3	3 56 *m*	11	4 35 *m*	292
„ 16 ...	Lalande 41601	6·8	—	—	9 28 *e*	266
„ 16 ...	BD − 14°·6039	7·0	—	—	11 30 *e*	225
„ 18 ...	BD − 8°·5873	7·0	—	—	0 49 *m*	250
„ 18 ...	186 B Aquarii	6·1	2 47 *m*	36	3 53 *m*	254
„ 23 ...	66 Arietis	6·1	11 22 *e*	114	11 59 *e*	212
			—			

The asterisk indicates the day following that given in the date column.

From New to Full Disappearances occur at the Dark Limb; from Full to New, Reäppearances.

VARIABLE STARS.—Stars reaching their maxima in or near July, 1916, are included. The lists in recent months may also be consulted. (See Table 32.)

NOTE.—Since the above was written the Daylight Saving Act has come into force, and therefore one hour must be added to the times of all phenomena given in this article in order to obtain the time of their occurrence according to civil reckoning. For example, "Greenwich Noon" will occur at 1 p.m. (civil reckoning), and the occultation disappearance of 65 B Scorpii will occur at $11^h\ 57^m$ p.m. (civil reckoning). The best way of avoiding confusion in all astronomical matters will be to call the new time "Mid-European Time," a name already in use to denote time one hour ahead of Greenwich Time; while the term "Greenwich Mean Time" must be reserved for the old system, which will, of course, continue to be used in all matters of astronomical calculation.

NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

HALLEY'S COMET.—The Astronomical and Astrophysical Society of America realised in good time the importance of maintaining a continuous watch on this comet about the time of its nearest approach to the Sun and Earth in 1910. As the time available at any particular station would be only an hour or two each day, owing to the proximity of the comet to the Sun, the record could only be made continuous by the multiplication of stations. In particular, it was desirable to occupy the region of the Pacific Ocean. A grant from the National Academy of Sciences made it possible to send Mr. Ellerman, of Mount Wilson Solar Observatory, to Hawaii in April, 1910, where he set up his instruments at Diamond Head, in an extinct crater. The weather conditions there were the best on the island, the chief difficulty being the high wind, which sometimes necessitated the interruption of exposures. Series of photographs were taken with cameras of thirty-two and nine and a quarter inches focus. The larger scale showed the tail very conspicuously up to the edge of the plate, a distance of 10° from the head. The maximum length of tail photographed with the small one was 50° on May 14th. Many of the photographs are reproduced, and show much interesting detail. Both the main tail and the side ones frequently exhibit a filamentary structure. On May 8th and June 6th the main tail was decidedly curved. On the latter date some detached luminous masses are visible in it. On May 28th the main tail was very narrow where it left the nucleus, the appearance being quite different from that on most of the days. The reproductions show a large number of stars, which, if identified, would enable the position of the tail boundaries to be laid down very precisely. It seems likely that we did not traverse the denser part of the tail, but there was a wide region of fainter light outside this which probably enveloped the Earth. A dark rift down the axis of the tail is plainly shown on several photographs. This feature has been seen in many comets, and suggested the idea that the tail might be a hollow cone. The report contains a useful (though not quite complete) list of photographs of the comet obtained at other observatories, which should be of service to students of its physical features. The transit of the comet across the Sun's disc occurred in the late afternoon at Hawaii. Careful visual search was made with the 6·4-inch telescope, but no trace of the comet was seen.

MARS.—The April number of *Popular Astronomy* is largely taken up with this planet. Mr. Harry Hussey, of the Mount Wilson Observatory, describes a visit to Flagstaff, and makes the following remarks on the aspect of Mars: "There came one of those periods of superlative seeing for which this observatory is famous; and not only the Propontis, but every marking on the planet, was as plain to be seen as if it was a photograph or a printed map. . . . At the Lowell Observatory there are certainly periods during a night of good seeing when the seeing is perfection; and, adding to this a flawless objective, one should not be surprised at the results obtained by the observers." Many other visitors to Flagstaff have given similar testimony to the excellence both of the seeing and of the object-glass of the twenty-four-inch equatorial. This naturally tends to increase our confidence in the accuracy of the Flagstaff observations. Mr. Hussey notes that he has seen canals with the sixty-inch reflector at Mount Wilson, though, as might be expected, definition was far inferior to that at Flagstaff. Great reflectors are designed to give sufficient light-grasp to see or photograph faint stars or nebulae. It would be unreasonable to expect their figure to be so perfect as to give good definition of very delicate planetary detail. Moreover, the great diameter of the pencil of light increases atmospheric disturbances. Professor W. H. Pickering's monthly article gives some useful hints to beginners on drawing the planet, showing how to prepare discs on which the axis and the dark lune are correctly marked. The data required are given in *The Nautical Almanac* and in our monthly "Face of the Sky."

XUM

He goes on to establish some further cases of shift of markings, some of which amount to five hundred miles. Owing to this liability to shift, determinations of the rotation period that are based on short time-intervals are liable to considerable error. Both Pickering and Lowell agree that the southern Maria were brown at the beginning of this year. As it was then late autumn in the southern hemisphere, the brown would accord well with the theory that the Maria are covered with vegetation, appearing blue-green during the spring and summer, and becoming brown in the autumn. The blue-green was actually seen at the time in Syrtis Major, north of the equator, and elsewhere. Some of the Maria, notably Acidalium, appeared so blue that they were concluded to be covered with water, this conclusion being strengthened by the fact that they were frequently accompanied by cloud.

A useful map, drawn some years ago by M. E. M. Antoniadi, accompanies the article. It shows all the Maria and more prominent canals, with their names clearly inserted. Such a map is a necessity to students, as without it the descriptions of observers are unintelligible. It will be remembered that M. E. M. Antoniadi has, since the opposition of 1909, expressed his conviction that the straight geometrical appearance of the canals is an illusion, and that they are complicated and irregular details, too small to be clearly defined. The map in question was drawn before 1909, and shows the geometrical pattern, which corresponds with the aspect in most telescopes, whatever may be the truth as to the objective reality.

STATISTICS OF THE PLANETARY ORBITS.—Professor H. C. Plummer has an article on this subject in *The Monthly Notices* for March. He applies analysis to the orbits of the first eight hundred and nine minor planets, and finds a strong tendency for their perihelia to group round the perihelion of Jupiter. M. Callandreau had noted the same relation in the orbits of the short-period comets. The mean eccentricity is 0·117. This is exceeded among the primary planets by Mercury only, with the value 0·2; that of Mars is 0·093. The mean pole of the orbit planes is 0°·9 from the pole of the ecliptic in longitude 17°. A diagram is given of the poles of the orbit-planes of the major planets, showing the remarkable result that they are grouped by threes in a series of straight lines as follows :—

(1) Mercury, Venus, Saturn.
(2) Venus, Earth, Uranus.
(3) Mercury, Earth, Mars.
(4) Mars, Jupiter, Neptune.
(5) Jupiter, Saturn, Uranus.
(6) Mean Minor Planet, Uranus, Neptune.

Lines 2, 3, 5 had been noticed before, but their significance becomes much greater when it is seen that the whole planetary system shares in the arrangement. It can scarcely be an accident that this linear grouping is so closely fulfilled at the present time. Since the poles are moving slowly under the influence of perturbations, it remains to be investigated whether the linear arrangement will be permanently maintained. The pole of the invariable plane of the system lies very near line 5, as is to be expected, since Jupiter and Saturn have the greatest weight in determining its position. Also the pole of the Sun's equator lies very near line 2.

Professor Plummer makes the suggestion that, in getting a first approximation to the orbit of a new minor planet, it would be better to assume the orbit an ellipse, with eccentricity 0·12, and longitude of perihelion the same as that of Jupiter, than to assume it a circle.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (OXON), F.I.C.

AN ANCIENT ROMAN POMADE.—An ancient Roman vase, discovered at Ticino, contained a soft, yellowish brown mass, with an odour recalling that of storax and turpentine. This ointment has been analysed by M. L. Reutter, who has published his conclusions in a recent issue of the *Comptes Rendus* (1916, CLVII, 470). Applied to the skin, it gave a pronounced yellow coloration, which was attributed to the presence of henna. It melted at 58° C. to a yellow liquid containing numerous mineral and vegetable impurities in suspension. It was partially soluble in petroleum spirit and in ether, and examination of the fractions separated by treatment with various solvents showed that it consisted of a mixture of beeswax and fat, to which had been added a little storax and oil of turpentine. The presence of tartrates suggested that the preparation had probably been macerated with wine, and the general conclusion drawn was that it had been intended for use as a toilet cream.

SPIDER SILK.—Dr. A. Herzog, writing in *Kunststoffe* (1915, V, 25), gives a description of the "silk" excreted by the Madagascar spider, *Nephila madagascariensis*. The fibres are very fine and lustrous, and are colourless or orange-yellow. Examined under the microscope, the fibre is seen to be solid, nearly transparent, and devoid of internal structure. It has an average diameter of only 6·9 μ, and is thus of less diameter than the finest artificial silks. Unlike ordinary silk, it is not coated with any substance corresponding to sericin. Its density and chemical properties closely resemble those of ordinary silk. When immersed in water it swells up, and at the same time contracts considerably in length.

SOLIDIFICATION OF OILS.—Apart from the process of hydrogenation, a description of which has been given in these columns, many processes of converting liquid oils into solid fats have been tried. One of the most interesting of these was based on Varrentrapp's reaction, according to which oleïc acid, when fused with potassium hydroxide, yields potassium palmitate and free hydrogen. An industrial process based on this was tried many years ago in France, but was subsequently abandoned mainly owing to the danger involved in the evolution of large volumes of hydrogen.

Recently, however, the process has been revived, and a description of its new applications is given in the *Zeit. angew. Chem.* (1916, XXVI, 31). It is stated that all unsaturated fatty acids are thus transformed into saturated fatty acids containing a smaller number of carbon atoms. For example, clupanodonic acid, to which whale and fish oils owe their characteristic unpleasant odour, is slowly converted into solid saturated acids, so that it is possible in this way to obtain up to eight-five per cent. of white solid distillate from the mixed fatty acids of these oils. Marine animal oils yield tallow-like fats, which when mixed with other fats can be converted into soaps of good quality. Moreover, products may thus be obtained from refuse fish oils, which closely resemble the fatty acids of coco-nut and palm-nut oils, the demand for which has long since exceeded the supply.

GEOGRAPHY.

By A. SCOTT, M.A., B.Sc.

CORAL REEFS AND CRUST-MOVEMENTS.—Two papers on this subject appear in the January number of *The American Journal of Science*. In the first, T. W. Vaughan summarises our present knowledge concerning the origin of barrier reefs, and concludes in favour of the Darwin-Dana hypothesis (cf. "KNOWLEDGE," September, 1915; February, 1916) in several particulars. He holds that the chief points still at issue are the origin of the platforms and the cause of the submergence. The investigation of the latter has not proceeded very far, and the only conclusion reached is that it is connected with diastrophic changes, and not with local causes. The former point is treated by E. C. Andrews in the second paper. A detailed examination of the Fiji Islands shows that the barrier reefs "are due to the upward and outward growth of coral reef-organisms on

land areas recently submerged"; while in the case of the Great Barrier Reef of Australia the evidence of recent coastal submergence is very definite. The individual islands of the Fiji Group show some differences, particularly with regard to the amounts of submergence and emergence; but the evidence is generally in favour of the above conclusion.

THE ASTROLABE À PRISM.—In the May number of *The Geographical Journal* Major Woodroffe gives a description of this instrument and of its use for the determination of time and latitude. The instrument consists essentially of a telescope, which can rotate about a horizontal axis, and which has a 60° prism mounted at the objective end. Fixed to the telescope, some distance below the prism, is a mercury trough. On setting the instrument in the direction of a star with an approximate altitude of 60°, two images—one direct and the other reflected from the mercury surface—are seen. By means of an adjustment the two images are brought on to the same vertical wire and equidistant from a horizontal wire. The time of coincidence of the two images is noted and the azimuth read. The computation is based on Gauss's method, but is greatly simplified by a graphical method. Where a number of observations are to be made between known parallels of latitude, the work may be further simplified by the compilation of tables giving azimuth and sidereal times when stars are at an altitude of 60°. The instrument has many advantages, being light, comparatively simple and accurate, and necessitating no instrumental corrections. The timing of the coincidence, however, must be very accurate, and in field work Major Woodroffe found an "eye and ear" method preferable to any other.

WIRELESS TIME-SIGNALS.—In the same paper the author gives some notes on the determination of longitude by means of wireless time-signals. The following arrangement has been found to give good results. A pendulum, with a beat of 49/50 sidereal second, is attached by means of a relay to the sending circuit, so that a signal is sent out at every beat. The observer at the receiving end compares these signals with a sidereal chronometer beating half-seconds, and notes the coincidences which occur every twenty-five seconds. Two sets of signals, each giving ten coincidences, are usually sufficient, and with the arrangement of a suitable programme of signals and the application of the chronometer correction the sidereal times of the two positions can be determined, and hence their difference in longitude. The method, which is also very accurate, does away with the necessity of cutting traverses, which alone would be sufficient to recommend it, particularly in difficult country such as the dis ricts of the Upper Amazon.

GEOLOGY.

STRUCTURES IN SEDIMENTARY ROCKS.—The structures shown by the igneous rocks have at all times attracted attention from petrologists, and a vast literature has grown up on the subject, though even now some important questions cannot be regarded as finally settled. But with the sediments the case is rather different. The study of the characteristic structures has received much less attention than it deserved, and a very large field is still open for investigation. At last, however, there are signs that the sedimentary rocks are attracting the attention of petrologists, and a good deal of work has already been done on their mineral composition, especially with a view to discovering the sources of the material. One of the pioneers in this kind of work was Professor Bonney, who was President of the Geological Section of the British Association at Birmingham in 1886. In his presidential address he gave a most interesting summary of the then state of our knowledge on the subject, chiefly based on a study of thin slices of the rocks. The late Dr. Sorby, of Sheffield, also did a good deal of work on the sedimentary rocks, his last work being devoted to conditions of deposition in moving water. In the last few years several workers have adapted modern methods of research to the study of the composition of sediments of many geological ages, the most important of these methods being separation of the minerals in heavy liquids.

Although we have obtained in this way a considerable amount of information as to the mineral composition of the rocks, this alone is incomplete, unless accompanied by a careful study of the structures, both on a large scale and microscopic; and, in fact, an examination of the separated material alone by the methods just mentioned may be actually misleading unless the structures are also taken into account. Both composition and structures are of equal importance in elucidating the conditions of formation.

Many of the forms assumed by masses of sediment are very remarkable and extraordinarily difficult to explain. Even the existence of the commonest forms of concretions in limestones and shales has never been satisfactorily accounted for, and the origin of flints has been a long-standing subject of controversy. But there are other and simpler subjects that also require investigation, such as false bedding, many forms of lenticular structure, contortions in apparently undisturbed strata, and others too numerous to mention individually. A recent paper, by Mr. Bernard Smith, in *The Geological Magazine* (1916, page 146) on "Ball or Pillow-form Structures in Sandstones" affords an excellent example of the kind of work that is so much needed on these lines. The sandstones here described form part of the Ordovician system in Denbighshire (Llandeilo and Bala series), and occur as lenticular masses in shales. Some of the blocks of sandstone are almost spherical in form, while others strongly resemble the "pillows" so often seen in lavas. Both types show a very well-marked division into concentric shells, very like the orbicular jointing so common in the dolerites. But the strangest fact of all is that the bedding planes of the sandstone are often curved parallel to the surface of the pillows. In other instances a spherical ball may consist of strongly contorted laminated sandstone, the bedding planes showing no relation whatever to the external form of the mass. The reason for these curious relations cannot be discussed here, and this particular instance is only mentioned as an example of the kind of fact worth recording.

A vast field of research is here open to geologists, and one of great promise. This kind of work also possesses certain advantages in that it requires little or no special apparatus. All that is required at present is a careful record of observations and collection of specimens, accompanied, if possible, by photographs, or, better still, by careful drawings to scale. A detailed study of any sedimentary formation, carried out on the lines thus briefly indicated, could not fail to throw light on some of the most puzzling problems that confront the stratigraphical geologist.

R. H. R.

THE ORIGIN OF ANTHRACITE.—The publication of a new edition of *The Geological Survey Memoir* on the coals of South Wales and the great importance at the present time of the Welsh anthracites may render a few words on this subject, at any rate, of some interest. The formation of coal has been for a long time a matter on which very varied opinions have been held. The original idea, which is still widely prevalent, was that all coals were derived from peat or swamp deposits, which were gradually changed during the course of ages. This change was attributed to various causes, the chief of which were earth-movements and rise of temperature, the latter being due either to the intrusion of igneous rocks, or to the burying of the seams below great thicknesses of sediment. When, however, the effect of these agents upon coals are studied, and other facts are taken into account, the old theory is found to be quite untenable. In the first place, the formation of coal, instead of being an age-long process, seems to have been moderately rapid. This is shown by the occurrences of "washouts,"

or valleys filled with sandstone and rubble in the Coal-measures, containing pebbles of true coal with alternate bright and dark layers, and which show no signs of compression or contraction having taken place since they were embedded; and also by the occurrence of these coal pebbles in the Pennant grits in the middle of the coal-bearing series of the Bristol coalfield; which prove that coal existed as such in Upper Carboniferous times. In certain districts, such as the Radstock coalfield, where the rocks have been subjected to violent crumpling, ordinary humic coals are found, and in South Wales also the folding and faulting seem to have had very little effect. Here there are two main fold-directions—east and west and west-south-west—and also faulting along north and south lines. Both folding and faulting cross bituminous and anthracitic areas, and very little effect is produced, the coals keeping the character proper to their area, irrespective of the disturbances. Observations on the effects of thermal metamorphism on the coals seem to point in the same direction. Certainly the same seam may be rather more anthracitic in the synclines than in the anticlines; but this difference is very slight, and bituminous coals are found both in the places where the measures are thickest and where they are thinnest. The effect of intruded igneous rocks, where it can be seen in other districts, is merely that of a local coking, and nothing more. In this connection we may cite the fact of the extremely low ash percentage found in almost all anthracites, the proportion being 3·43 per cent. in bituminous coals to 2·5 per cent. in anthracites. Now, if the logical conclusions of the "peat-to-anthracite" theory are followed up, it will be seen that the anthracite end of the series should show a much larger ash percentage than the peaty end, owing to the loss of volatile matter. This, however, is not the case, and the obvious inference which may be drawn is that the original "mother substance" of anthracite was radically different from that of bituminous coal. This is borne out by an analysis performed on dull and bright layers from the same lump of coal. The two are undoubtedly of different origin, the former being composed largely of flattened stems and bark, while the latter has no definite organic structure. The results obtained showed that the dull portion had a very much larger ash percentage than the bright, while the latter had more volatile matter. This theory of the peculiarity of the "mother substance" of anthracite is also supported by its general distribution. If for each seam, or group of seams, in South Wales the ratio of C : H is calculated, and the results plotted on the map, the lines along which this ratio is constant (iso-anthracitic lines) are seen to be parallel in a general east-north-east, west-south-west direction, with an increase of anthracitisation as they go north-north-west. This holds good for every seam, so that, generally speaking, in any given area each seam is more anthracitic than the one above it. Now, at the time of deposition of the Coal-measures overlap was taking place in a north-north-westerly direction, so that it may be taken that these lines of maximum anthracitisation followed the retreating shore line, and that at a certain distance from it, conditions were such as to favour the deposition of that particular "mother substance" which was to produce anthracite as we see it now. The actual process of the breaking down of the vegetable débris to coal is still a moot point; it is now often attributed to bacterial agencies, but lack of space prevents the discussion of the subject here.

W. H. W.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.Met.Soc.

REMARKABLE FALL OF HAIL IN MARYLAND.—Professor O. L. Fassig gives in *The Monthly Weather Review* (September, 1915) some particulars about a remarkable fall of hail which occurred over Maryland on the afternoon of June 22nd, 1915. Judging from the size of the hailstones alone, the storm seems to have passed over the city of Annapolis, although the stones were almost as large at some other places. The hailstones were of a size never before seen in the vicinity. The large ones were generally referred to as being the size of a baseball or an orange. Two officials of the United States Naval Academy accurately measured ten or twelve stones, which gave an average diameter of 3½-in. × 3-in. In other series of measurements the largest stones exceeded four inches in diameter. These measurements are equivalent to a circumference ranging from ten to twelve inches. Some of the stones weighed six to seven ounces. The structure of the hail was similar to that usually met with, namely, a nucleus of snow or opaque ice, with concentric shells of alternately transparent and opaque ice. In some of the larger stones from twenty to twenty-five such layers were counted. The manner in which masses of ice are sustained in the atmosphere long enough to acquire a weight of many ounces is still something of a mystery. Ferrel suggested that the strong ascensional currents within a hailstorm carried the hailstones to great heights, receiving constant accretions on their way, and that it is probable that the hail, falling out of the strong ascensional currents, or being thrown out, may be repeatedly carried up to great altitudes, where the temperature is below freezing, and thus grow to great size before falling to the ground.

THE METEOROLOGY OF THE GLOBE IN 1911.—As the sequel of a long series of discussions at meetings of the International Meteorological Committee and its Commissions, the International Solar Commission, and other scientific organisations, the Committee of the Meteorological Office has authorised the preparation of an annual statement of the meteorology of the globe, beginning with 1911. As the volume for that year is now nearly ready for issue, Sir Napier Shaw exhibited several copies of the same at the meeting of the Royal Meteorological Society on March 15th, and said that it gives particulars of pressure, temperature, and rainfall for available stations in all parts of the globe at the rate of two stations for each ten-degree square of latitude and longitude. It also gives the differences from the normal in those cases in which normals existed or could be compiled. The number of stations is three hundred and ninety for a total of five hundred and seventy-six squares, omitting the regions beyond 80° north and south. The names of many are quite unfamiliar to the general reader, but the selection is interesting on account of the number of stations in British possessions which are for the first time adequaely 1epresented in at general meteorological summary. The values are given in absolute units for pressure and temperature. Positive and negative signs are therefore only used to indicate differences from the normal, except in two cases of negative sign in the column for height, which indicate that the stations are below sea level. A brief discussion of the meteorology of the year is based upon the differences from normal.

THE STORM OF MARCH 28TH, 1916.—The month of March was unusually dull and cold over the whole of the country, and was very wet over most of England, but rather dry elsewhere. The usual March winds were practically absent until nearly the close of the month. The most severe disturbance was that which passed over southern England on the 27th, accompanied by rain and snow-storms. The gale subsided on the morning of the 28th, but towards the evening, when the centre was crossing the Thames Valley, a violent northerly storm burst over the southern and midland counties, accompanied by a blizzard of snow. Vast numbers of trees were uprooted. It has been stated that from statistics compiled locally over twenty-one thousand trees fell during this storm within a twenty-mile radius of Hitchin. There was further extensive destruction of telegraph poles and wire, and railway traffic was completely disorganised for several days.

XUM

MICROSCOPY.

By F.R.M.S.

THE LATE MR. FREDERIC ENOCK.—With sorrow we record the death of Mr. Fred Enock, F.L.S., F.E.S., who died at Hastings on May 26th at the age of seventy-one years. There is no need to remind our microscopical readers of Mr. Enock's work. His skill, industry, and zeal are only too well known to them, and they will deplore his loss equally with the numerous lovers of nature who were edified and charmed by Mr. Enock's popular lectures. Mr. Enock was a peculiarly modest man, with a high ideal of perfection in detail, and he possessed a fund of ready humour. One first became familiar with his work from the illustrations which were published in *The Strand Magazine*, and from the striking articles which he contributed to "KNOWLEDGE" on insect life, such as that dealing with the leaf-cutter bee. One feature of the original research upon which both Mr. Enock's lectures and writings were based was that his material was taken from the wealth which lies close at hand. Of recent years Mr. Enock paid a great deal of attention to the Mymaridae, those minute hymenopterous insects which pass the early stages of their life-history in the eggs of other members of their class. The fairy-flies, as they have been well called, Mr. Enock learnt to mount for microscopical examination in a way which no one can hope to excel, and it is sincerely to be hoped that the monograph which he had in preparation, and for which he took many hundreds of photographs, will be published as a lasting memento of him.

W. M. W.

SOME PARASITIC FUNGI.—(1) *Epichloë Typhina*: This fungus (see Figure 112) is found on many grasses as a mouldy coating on the haulm, causing withering of the parts above. The spores are thread-like, and are contained in the asci, each of which contains eight spores. The specimen was collected from Alum Bay, Isle of Wight, and presented a bright yellow appearance when growing on the host. Arrowroot is another but uncommon host of this particular ascomycete. The section is particularly striking, as it shows how entirely the disease envelops the haulm of the grass; attacks fodder grasses as *Dactylis*, *Poa* and *Phleum pratense* (2) *Puccinia* on *Conopodium* (see Figure 110). This is, so far as can be ascertained, a new host plant for *Puccinia*. The aecidiospores have been found on this plant, and Soppitt claims relationship between this aecidium and *Puccinia Bistortae* on *Polygonum Bistorta* and *Polygonum biviparum*. The occurrence of teleutospores on *Conopodium* is not mentioned by Tabeuf and Smith in their most exhaustive work on this subject. As to which aecidium these teleutospores are related remains to be found. (3) *Coeoma Mercurialis*: This is not a new species of *Coeoma*, but the section shows an abnormal growth, so far as can be gathered from accounts published in this particular fungus growth. The aecidiospores grow normally in the cortical tissue, finally rupturing the epidermal tissue. Figure 111 shows an internal mass of spores growing right in the central portion of the stem. They seem to be isolated growths, surrounded by enlarged cells, filled with dense masses of hyphae. Both longitudinal and cross sections were cut from this particular specimen in different parts of the plant, and all exhibited this peculiar growth. The infected cell is shaped like a boat, as nearly as can be described, with its length and breadth in the proportion of three to one. The contained spores have every appearance of aecidiospores, with the exception that they are out of the usual latitude of their numerous relations.

H. C. WHITFIELD.

PHOTOGRAPHY.

By EDGAR SENIOR.

SEPIA TONING.—Of the many different processes for toning bromide and similar prints the simplest of all, as well as the most permanent, are those which yield brown or sepia tones by the sulphide method. The process, which is well known, consists of converting the silver image into either iodide, bromide, chloride, or ferrocyanide of silver, and finally by the use of a soluble sulphide into sulphide of silver, a substance which is brown, or yellowish brown, in colour, and resists the action of any chemical agent with the exception of strong nitric acid. The tone ultimately obtained depends to an extent upon the silver salt to which the image is converted, the warmest one resulting from the bromide, an intermediate shade from the iodide, while the coldest is usually secured from the chloride or ferrocyanide. The method usually adopted for converting the image into one or other of the haloid silver salts is through the agency of potassium ferricyanide, as this substance, when mixed with an iodide, bromide, or chloride of the same base, will first convert the silver into ferrocyanide, and this in its turn will be converted into the haloid salt. A few minutes' washing in running water will then remove the slight yellow stain, due to the ferricyanide, and the print is ready for the application of the sulphide solution. When the bleaching solution contains potassium ferricyanide, it is necessary that the prints be very thoroughly washed to free them from "hypo"; otherwise the ferricyanide and "hypo" will act as a reducing agent, and this may partly account for the very poor tones seen in many prints toned by this process. Then, again, any particles of iron present will give rise to blue spots in the print. Owing to these difficulties, and to the almost prohibitive price of potassium bromide now, the use of potassium permanganate, recommended recently as a bleaching agent in place of the ferricyanide by Mr. T. H. Greenall in *The British Journal of Photography*, should be welcomed, as from our own experience the tones obtained, whether upon bromide or gaslight papers, are everything that could be desired, and the cost of production about one-twentieth of that incurred when potassium ferricyanide and bromide is employed. The formula given for the bleaching solution is as follows:—

Potassium permanganate	2 grains
Common salt	90 ,,
Water	8 ounces
Sulphuric acid (strong)	20 minims

In making up the above solution, care must be taken that the permanganate is thoroughly dissolved. The prints, after bleaching, are washed for a few minutes in running water, and then placed in a solution of sodium sulphide of the following strength:—

Sodium sulphide	10 grains
Water	1 ounce

As soon as the toning action is complete the prints are again washed. In nearly all cases the permanganate will have imparted a yellowish brown stain to the paper. This, however, is almost instantly removed by placing the print in a one-per-cent. solution of oxalic acid, when after a final wash the print is placed to dry.

The chief advantage, therefore, of this process, apart from the fact that it is not necessary to get rid of the last trace of "hypo" from the print, lies in its cheapness and the ease with which good tones may be obtained. Intermediate tones can also be produced by partial bleaching, using the solution half-strength, and allowing it to act for about ten seconds only upon a print that has been thoroughly soaked in water, the sulphiding in this case resulting in a warm black. Potassium bichromate and sodium chloride also form a cheap and good bleaching agent as originally given in photography by Mr. R. E. Blake Smith, the following being the formula recommended:—

Potassium bichromate	9 grains
Sodium chloride	48 ,,
Water	1 ounce
Sulphuric acid (strong)	20 minims

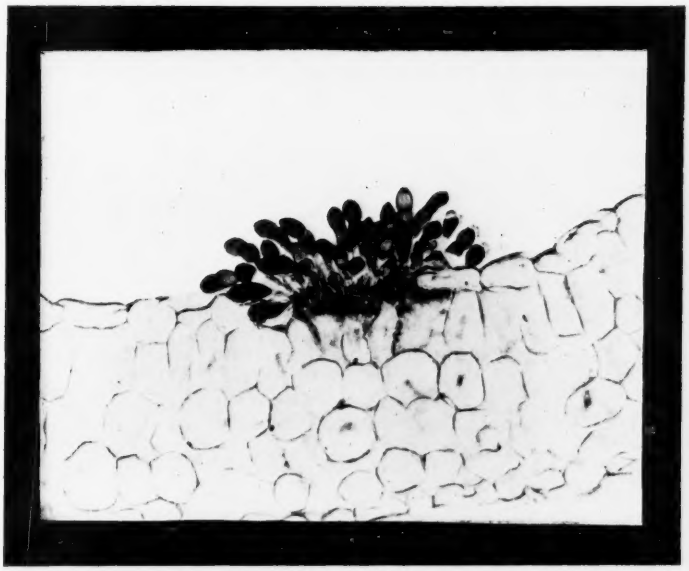

FIGURE 110. *Puccinia*: teleutospores on *Conopodium*.

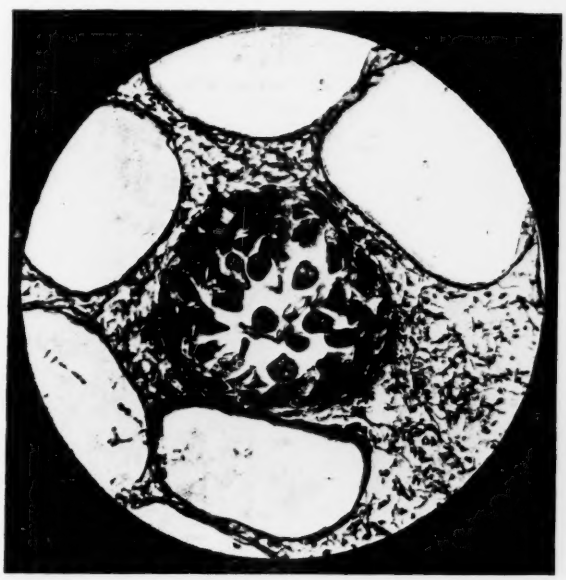

FIGURE 111. *Coeoma Mercurialis*.
Abnormal growth.

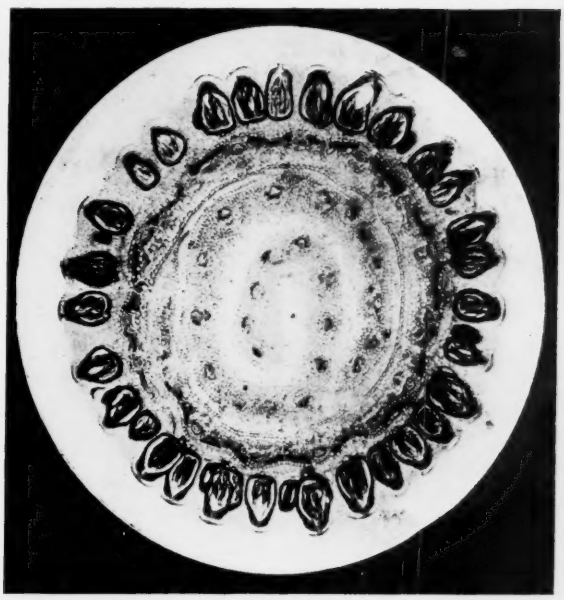

FIGURE 112. *Epichloë Typhina*
on Grass.

From photo-micrographs by H. C. Whitfield.

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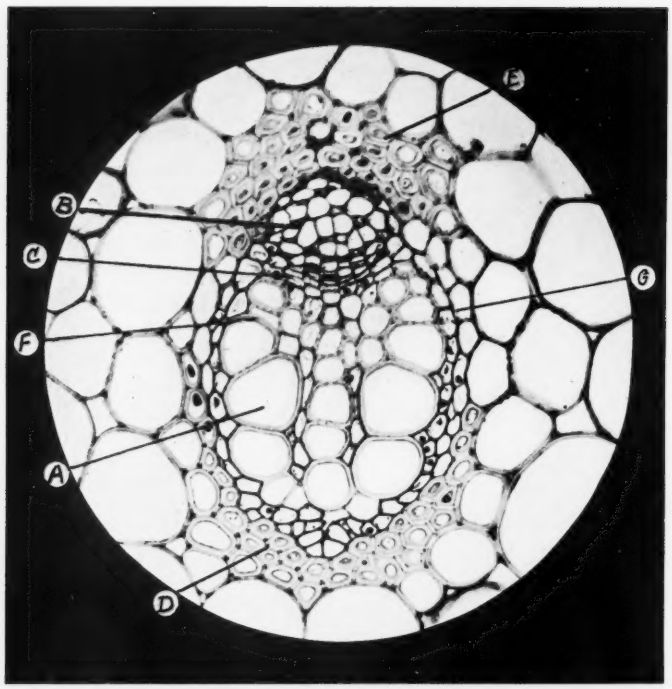

FIGURE 113. Transverse section of a fibro-vascular bundle of Great Spearwort. × 185 diameters.

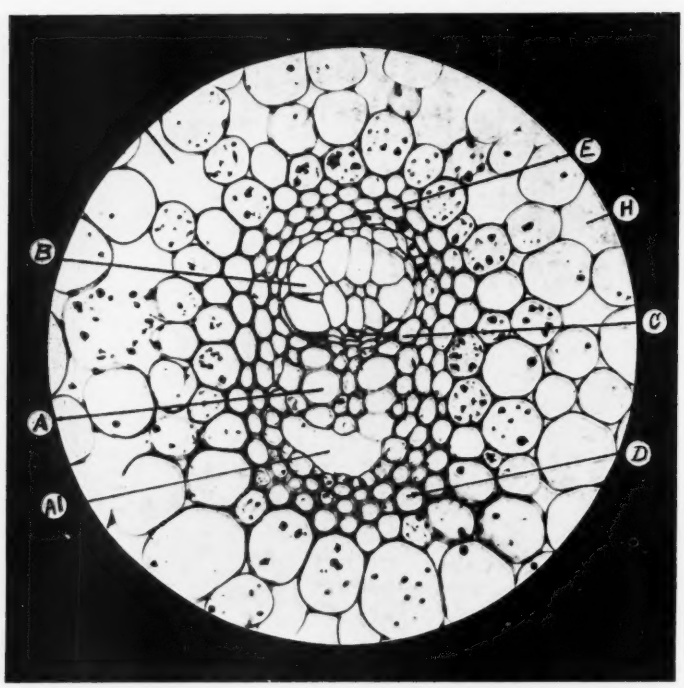

FIGURE 114. Transverse section of a fibro-vascular bundle of Water Crowfoot. × 220 diameters.

(From "The Practical Principles of Plain Photo-micrography," by George West. By the courtesy of the Author.)

(See Page 132.)

After bleaching, the prints must be thoroughly washed in running water until free from any yellow stain; and, if desired, the time necessary for this operation may be shortened by the use of an alum bath immediately after bleaching. When slight bleaching for the purpose of obtaining intermediate tones is required, then the bath should be diluted to about one-sixth of the strength given.

HARDENING ACTION OF ALUM IN THE FIXING BATH.—As the result of experiments conducted by MM. Lumière and Seyewetz concerning the hardening effect produced upon gelatine by the addition to the fixing bath of either ordinary alum or chrome alum, it appears that a comparison of the action of the two alums went to show that with a fifteen-per-cent. solution of "hypo" as the fixing bath the greatest insolubility was produced in the gelatine film by the presence in the fixing bath of 0·5 per cent. of chrome alum, as compared with 1·5 per cent. of ordinary alum; and not only is one-third of the quantity sufficient when chrome alum is employed, but its hardening effect upon gelatine is much superior, since the film will withstand a temperature of boiling water (212° F.); while with ordinary alum a temperature of 167° F. is quite enough to cause the gelatine to soften and come away from the glass. They further found that sodium bisulphite will prevent the decomposition of "hypo" by the alums, and recommend a fixing bath prepared according to the following formula :—

Sodium thiosulphate ("hypo") ...	3 ounces
Sodium bisulphite lye	100–150 minims
Chrome alum	50 grains
Water	20 ounces

Other fixing baths containing chrome alum are as follows :—

Sodium thiosulphate ("hypo") ...	4 ounces
Sodium sulphite	240 grains
Sulphuric acid	30 minims
Chrome alum	60 grains
Water	20 ounces

Dissolve the "hypo" and sodium sulphite in eighteen ounces of water, and then add the sulphuric acid in small quantities at a time, stirring the while. Lastly, add the chrome alum, dissolved in two ounces of water, to the bulk of solution, and the bath is ready for use.

No. 1.

Sodium thiosulphate ("hypo") ...	8 ounces
Sodium sulphite	1 ounce
Water	24 ounces.

No. 2.

Chrome alum	½ ounce
Water	8 ounces
Sulphuric acid	30 minims

Add No. 2 to No. 1, with continuous stirring. When using either of the fixing baths given the plates should be allowed to remain in them for at least five to ten minutes after the whole of the silver bromide appears to have been decomposed, as the permanence of the negative, its freedom from stain, and the hardening of the film will depend upon it.

REDUCING CONTRAST IN A NEGATIVE.—A common fault in many negatives is an excessive density in the high lights, and some method of reduction has to be resorted to that will remove this without affecting the rest of the image. Ammonium persulphate is now well known as a reducing agent of the kind required, but the uncertainty and irregularity of its action tend to deter many from using it. Owing, therefore, to the want of certainty which attends the use of persulphate of ammonium, a means of reducing the contrast in a negative, recommended by Dr. Eder, may be employed in its place. The method as originally given consists in converting the negative image into chloride or bromide of silver, and re-developing this to a stage short of reducing the whole of the silver salt in the high lights back to metallic silver. If the negative is then rinsed and placed in a solution of "hypo," the unreduced silver salt will be decomposed, and a corresponding reduction in density brought about. For converting the image into bromide of silver a solution of copper bromide is employed, and this may be prepared by dissolving copper sulphate and potassium bromide together in the following proportions :—

Copper sulphate	5 grains
Potassium bromide	5 ,,
Water	1 ounce

The negative, which, if dry, should be soaked in water for some ten minutes or so, is then bleached in the above solution, after which it is washed for about fifteen minutes, and then re-developed with a metal hydroquinone, or similar developer. The shadows will soon be fully developed, and the development may be allowed to proceed until all but the highest lights are completely reduced, or the action may be stopped at any stage desired by rinsing the plate and placing it in the fixing bath. It will be readily seen that by this method everything depends upon the re-development being stopped at the right moment. By a modification, however, that has been introduced by Mr. C. Welborne Piper, and published by him in *The British Journal of Photography*, any uncertainty of this nature has been overcome by the use of a developer that is incapable of developing the image to its former density. As a bleaching agent, he recommends a potassium ferricyanide and potassium bromide solution, prepared as follows :—

Potassium ferricyanide	15 grains
Potassium bromide	5 ,,
Water	1 ounce

After bleaching the image is washed, and then re-developed with a developer containing two per cent. of rodinal and one per cent. of potassium bromide, the formula being :—

Rodinal	100 minims
Potassium bromide	50 grains
Water	10 ounces

If preferred, azol may be employed in place of the rodinal, using the same quantity, when it will be found to work just as well. With either of these developers, used at a temperature of 55° F. for about thirty minutes, the density obtained in the negative will be equal to about sixty per cent. of the original, and will be nearly proportional throughout. Any slow-acting and very dilute developer, containing up to five grains of bromide per ounce, can, however, be used; and, as development may, of course, be watched, it is an easy matter to avoid carrying it too far or stopping it too soon. As soon as development is finished the negative is rinsed, and placed in the fixing bath to decompose the unreduced silver salt, when a final washing completes the operations.

PHYSICS.

By J. H. VINCENT, M.A., D.Sc., A.R.C.S.

A NEW METHOD OF DETERMINING GRAVITY AT SEA.—Briggs has successfully employed the method of observing the height of a mercurial column necessary to balance the pressure of a confined mass of gas for the evolution of gravity at sea. The apparatus has been used in measurements from Sydney to San Francisco, and from New York to San Francisco, via Panama. The mercurial column is contained in a capillary glass tube, bent into a zigzag form above the gas chamber to allow of slight adjustment, and expanding at the top of the capillary into an evacuated observing bulb, which contains a fixed iron point. The capillary tube is sealed through the upper wall of the gas chamber, the lower end of the capillary dipping beneath the mercury in the bottom of the chamber. The pressure of the gas is such that when the whole apparatus is at the temperature of melting ice the top of the column can be made to coincide with the fixed point by altering the height of the observing chamber with a micrometer

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screw. The gas volume is thus constant, and the relative value of gravity at two stations is inversely proportional to the height of the mercurial column. (*Science*, April 14th, 1916.)

EXPERIMENTS TO DETECT REFRACTION OF *X* RAYS.—Barkla contributes an interesting note on this subject to the April number of *The Philosophical Magazine*. Theory indicated that it was possible that by careful experiment refraction might in certain cases be detected. The refracting surfaces were crystal faces, and not ordinary optical surfaces, which would cause a masking of any true refractive effects. The final experiments were performed by allowing the radiation from an *x*-ray tube to pass successively through two narrow vertical slits in parallel lead screens, about fifty centimetres apart, on to a photographic plate at a distance of about one hundred and fifty centimetres from the second screen. The photographic impression produced by the pencil of radiation was then a thin vertical line, three centimetres long and about ·01 centimetre in width. A few centimetres away from the second lead screen were placed two crystals of potassium bromide, arranged as two refracting prisms, end to end —that is, one above the other—with refracting edges vertical, but with their bases on opposite sides of the transmitted radiation. Thus any refraction of the radiation in transmission through the prisms would result in displacements in opposite directions of the upper and lower halves of the thin pencil of radiation. An exposure of a rapid plate was made for a period of from five to eight hours. It was found that the photographic impression was still a straight line from top to bottom. It was concluded that, if the refractive index for the radiation was not unity, it did not differ from unity by more than five parts in a million.

AN ENCLOSED CADMIUM VAPOUR ARC LAMP. —After extensive preliminary research Sand has constructed a cadmium arc lamp which for optical and other laboratory purposes is an unqualified success. It is run at a fairly high temperature, the cadmium being melted by means of a Bunsen burner before starting, so that the arc may be struck by tilting. The temperature of the lamp when lit is high enough to keep the metal molten and to prevent condensation of vapour on the envelope of quartz glass.

The removal of any oxide and of dissolved gases is accomplished by filtration in a vacuum when the lamp is being made. The clean, pure cadmium sticks to the quartz, and this would cause fracture of the envelope unless prevented in some way. Sand gets over this trouble by introducing into the lamp a small quantity of finely divided zirconia which completely obviates the difficulty.

The lamp consists of an inverted U tube, the shorter cathode side and the longer anode limb being both continued downwards as thick-walled capillary tubes through which the leads of tungsten wire pass. The wires are sealed at the bottom of the tubes by Sand's lead seal. Owing to the fact that the small upper chamber holds the cathode, the metal distils into it from the hotter lower anode, and drips back again every two or three minutes, causing a slight flicker, which does not, however, interfere with the use of the lamp. (Sand, *Proc. Phys. Soc.*, February, 1916.)

A METHOD OF EXHIBITING THE VELOCITY OF IODINE IONS IN SOLUTION.—A glass U-tube of the total length of fifty centimetres, with widened ends, is placed vertically. The electrodes of platinum foil are contained in the widened ends, and the limbs are filled with equally concentrated solutions (about ·1 gramme molecule per litre) of potassium chloride and potassium iodide respectively. Both solutions, however, also contain a small quantity of mercuric chloride. At the bend of the tube, where the two solutions come in contact, a disc of yellow mercuric iodide is precipitated by the action of the potassium iodide upon the mercuric chloride in the potassium chloride solution. The disc is sharply defined, because mercuric iodide is insoluble in potassium chloride and dissolves in potassium iodide. Thus the disc marks out clearly the boundary between the two electrolytes. The electrodes are now joined to the one hundred-volt. direct-current mains, so that the current enters by the potassium chloride limb. The boundary disc moves about a millimetre a minute against the direction of the current. By taking suitable precautions the apparatus may be used for quantitative work. (S. W. J. Smith, *Phys. Soc. Proc.*, April 15th, 1916.)

RADIO-ACTIVITY.

By ALEXANDER FLECK, D.Sc.

THORIUM ACTIVE DEPOSIT.—About a year ago (see "KNOWLEDGE," 1915, Vol. XXXIII, page 118) attention was directed to some experiments by Wood (*Proceedings Physical Society*, Vol. XXVI, page 248), from which it was deduced that thorium-C was composed of two bodies, which had slightly different properties, so far as volatilisation was concerned. At that time it was stated that if these results were verified far-reaching changes in our ideas of isotopes might be necessary. Such changes are not now demanded. The experimental work has been repeated by Stanislaw Loria (*Physikal. Zeitsch.*, 1916, Vol. XVII, page 6), and the actual observations made by Wood confirmed. The same set of experiments have, however, been made for radium, and the same types of observations were obtained, an inflection being obtained after thirty-five per cent. of the radium-C had been volatilised. It is therefore proved that this inflection has nothing to do with the fact that thirty-five per cent. of thorium-C disintegrates one way and sixty-five per cent. the other, because for radium-C the two modes of disintegration are in the proportion of 99·97 per cent. and 0·03 per cent. Loria puts forward the explanation that the slight difference in volatilisation is caused by some change in the physical properties of the oxides of the C elements, which are isotopic with bismuth.

ISOTOPIC ELEMENTS.—One paper by Fajans and another by Hevesy and Paneth deal with the general properties of these elements in a recent number of the *Physikalische Zeitschrift*. No actual addition to our knowledge concerning these elements is made, and both papers are somewhat argumentative, devoting considerable space to discussing whether the properties of isotopic elements should be called "identical," or "equal," or "substitutional." Hevesy and Paneth express the opinion that their experiments in which they measured the E.M.F.'s between a platinum electrode and a dilute lead solution, and between the same electrode and a radium-D solution of the same dilution as the lead solution, and found the two values to be the same, form better evidence on which to base our ideas of isotopic elements than the original precipitation experiments. These last experiments they regard as somewhat open to suspicion on the ground that adsorption phenomena play a large but unknown part. This criticism may be valid in a number of cases, but there are a number of others, such as actinium and mesothorium-2, to which it does not apply, since neither of the isotopes is present in weighable quantity.

ELECTRIC CHARGE ON RECOIL PARTICLES.—The work of various experimenters on this subject has frequently been mentioned in this column, and now another paper of considerable importance falls to be recorded. It appears in the *Comptes Rendus* (Vol. 161, page 696), and the author is Louis Wertenstein. The question which is under dispute can be briefly stated: "whether the recoil atom immediately after an α ray has been expelled does or does not carry a charge of electricity." It is well known that in the course of its path through air the recoil atom possesses a charge of positive electricity; but this may be acquired by collision with other atoms, and does not exclude the possibility of the recoil atom being sent on its path with no charge at all.

Wertenstein placed a quantity of radium-C on a wire held at the axis of an insulated metallic cylinder connected with

an electrometer. The apparatus was exhausted by a Gaede vacuum pump, so that there was a very high vacuum between the source of rays and the cylinder. Two screens of aluminium, of thickness $0{\cdot}7 \times 10^{-4}$ centimetres and $0{\cdot}5 \times 10^{-2}$ centimetres respectively, operated by electromagnetic means, could be placed at will between the wire and the cylinder. The object of the thin screen was to stop the recoiled atoms of radium-D, allowing the α rays to reach the cylinder, while the thick screen absorbed both the recoiled atoms and the α rays. An experiment consisted in making three measurements: (1) With both screens removed; (2) with the thin screen interposed; and (3) with the thick screen in position. The difference between the values obtained for (1) and (2) gives a measure of the electric charge carried by the recoiled atoms, while the difference between the corresponding values for (2) and (3) gives the charge carried by the α rays.

The results of the experiments show that in a very high vacuum, where the pressure is only 0·6 dyne per square centimetre, the recoiled particles carry no electric charge; as, however, the pressure rises, they gradually gain a positive electric charge through contact with other atoms.

The author adopts the notation of "α rays" for the recoiled particles. The paper in the *Comptes Rendus* is a good example of the difficulty of distinguishing between the α rays (recoiled atoms) and the ordinary α rays. If it is necessary to have some special notation for the recoiled particles, some symbol more easily distinguished from α should be adopted.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

POISON OF CENTIPEDES.—Dr. J. W. Cornwall has studied the poison of some Indian centipedes of the family Scolopendridae. It oozes out at a minute opening near the tip of the poison-claws, but its toxic action is relatively low. In fact, the investigator has come to doubt whether poisoning is the main function of the secretion. He suggests that it may contain digestive ferments.

CETACEA STRANDED ON BRITISH COASTS DURING 1915.—Dr. S. F. Harmer has issued a report on the stranded cetaceans of last year. There were only twenty-eight recorded, as compared with seventy-six in 1913 and fifty-seven in 1914. Although the number has been unduly small, the year has been of exceptional interest in including a record of Cuvier's whale (*Ziphius cavirostris*), the third British specimen. There was also a Sowerby's whale (*Mesoplodon bidens*), which, like Cuvier's, came ashore on the Wexford coast. Several of the rorquals recorded seem to have been killed or wounded by mines.

WHY DO POTATO-BEETLES HIDE THEIR EGGS?—It is well known that Chrysomelid beetles lay their eggs on the under-surfaces of leaves. The formidable potato-beetle lays its eggs on the under-surface of the leaves of the potato. It has been suggested that this saves them from being eaten by birds and other hungry creatures. But Professor R. W. Hegner has made experiments, which show that exposure to sunlight, while not retarding development, keeps the eggs from hatching. The non-hatching is probably due to partial desiccation.

PROTECTIVE COLORATION.—In studying the animals associated with feather-stars on the tropical coral-reef at Murray Island, Mr. F. A. Potts observed that the majority showed colour resemblance. The commonest Crinoid was *Comanthus annulatum*, with very variable coloration, but the associated Alpheidae always corresponded. He also calls attention to the case of the bright blue starfish, *Linckia laevigata*, was a source of food to multitudes of tiny Copepods (*Linckiomolgus coeruleus*), whose colour exactly matches that of the host, though the pigment is of a different chemical nature.

SPONGE VERSUS SPONGE.—Nelson Annandale, the indefatigable Superintendent of the Natural History part of the Indian Museum at Calcutta, has made an interesting study of small sponges which attack the burrowing Clionid sponges, and sometimes become almost parasitic on them. In most cases the invader of the burrow thrusts the Clionid before it, but in some instances it is possible that the newcomer actually engulfs and digests the proper occupant. The Clionids secrete a protective horny coat where the invader comes in contact with them, and transverse diaphragms in the galleries may also be a means of defence. The production and elaboration of gemmules may have the same significance.

HABITS OF FATHER-LASHER.—R. Elmhirst, of the Millport Marine Station, records some interesting observations on *Cottus bubalis* and *C. scorpius*, two common shore fishes. The colours of the males are very bright during the breeding season, and there is an excited display before the female. The rapidity of the respiratory act and the general behaviour suggest considerable excitement. The male of *C. bubalis* will rush open-mouthed at the female, and engulf half her head in his mouth. The three females observed died within a few days of spawning. After fertilising the eggs, the male mounts guard. "During the whole period—five to six weeks—of the development of the eggs, the male never appeared to go more than a few inches from them (unless when forcibly driven away), and certainly would not allow any other fish (except another female when spawning) to lie on or under the stone where the spawn was." Mr. Elmhirst found no evidence of the supposed nest-building by the male Cottus.

SENSE OF SMELL IN DOGS.—A case reported by Miss Adele M. Field, whose work on the sense of smell in ants is well known, is not in any way remarkable, but has a certain precision worthy of imitation. In the winter of 1911–12 she spent four months in the city of Tuscon, Arizona, and was wont to walk several times a day for a quarter of a mile through a residential part of the town, where most of the householders keep watch-dogs. In her earliest journeyings all the dogs barked at her almost intolerably. She made no efforts at conciliation, no acquaintance with the owners, no calls; but gradually the barking subsided, first on the side of the street that she usually traversed, afterwards on the other side also. All the dogs eventually stopped barking either by day or night. In the evenings she usually carried a lantern, the light of which fell upon the pavement without illuminating her. That the dogs recognised her in the dark and at a distance of many yards, and refrained from any vocal exercise, save a monosyllabic assertion of being on duty, indicates high olfactory sensitivity.

HIBERNATION OF WOODCHUCK.—One of the theories of winter sleep is that excess of CO_2 in the blood and tissues causes a state of torpidity, or narcosis, and that when the CO_2 reaches a certain concentration the respiratory centre is excited, respiration accelerated, and the muscles become hyper-irritable. These culminating results are responsible for the awakening from dormancy. A suggestion of this theory was stated by Paul Bert, and it has been worked out independently by Dubois, who maintains, for instance, that active European marmots pass into typical hibernating sleep when they breathe a mixture of air (forty-three per cent.), CO_2 (forty-five per cent.), and oxygen (twelve per cent.). Torpid marmots remain dormant if supplied with this mixture; but by increasing the amount of CO_2 the animals may be made to double their rate of respiration in ten minutes, and may awaken quite naturally. A. T. Rasmussen has recently followed this up by an enquiry into the oxygen and carbon dioxide content of the blood during the hibernation of the woodchuck (*Marmota monax*). The amount of CO_2 in the blood is at all times great as compared with that of most of the other mammals whose blood has been analysed. The amount increases progressively during hibernation, and decreases again

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after waking up. There is also a larger percentage of oxygen in the arterial blood just preceding and during torpidity than at other times. The difference between the amount of CO_2 in arterial and that in the venous blood is much greater during hibernation, and the same is generally true as regards the amount of oxygen.

PHYSIOLOGY OF MIGRATION OF FISHES.—Many years ago Maitland called attention to the strength of the impulse which prompts smolts to make for the sea. Many of his smolts—two and a half years old or more—threw themselves out of the pond where they had been reared. Some of them were approaching sexual maturity, and some of their eggs were artificially fertilised with success. They developed into vigorous offspring up to twenty months. As Day and others have shown, a sojourn in salt water is not necessary for the development of the sex-cells. What are the conditions prompting the search for the sea? Perhaps we may profitably distinguish (*a*) conditions in the nervous system, which has become a register of past experiences, racial or individual, or both; and (*b*) conditions in the general constitution which interact with the former.

The maturation of the reproductive organs influences the metabolism of the body. This increases the carbon-dioxide content of the blood; this accentuates the general irritability; and this increases the range and vigour of movements. Moreover, it has been shown, by Morris M. Wells and others, that changes in metabolism alter the reäctions of fishes to chemicals in the water, to specific gravity, and to currents. Thus we are beginning to get at the physiology of migration.

Two extremes have to be avoided. On the one hand, the salmon is not moved by a longing for the sea associated with pictures of toothsome crustaceans and the like. Yet what has been engrained in the nervous system counts for something. It probably gives point to the endeavour and purposiveness (not purposefulness) of the search for conditions of optimum stimulation.

On the other hand, the creature is more than a collocation of little chemical laboratories, which set one another a-going automatically, and work out an effective total reäction. This is too magical. Integration is required, and registration of previous experiences must be assumed. Yet every detail of the physiological description to which we have alluded is valuable, for the creature does not work without means.

REÄCTIONS OF THE SALMON.—In the fertilised egg and newly hatched fry the rate of oxidation is high, as Loeb has shown. From this time on to maturity, as Wells has shown, the rate runs down. Wells writes (*Journ. Exper. Zoölogy*, 1915): "Salmon eggs hatched in fresh water must develop into fry, which are able to live in slightly acid water, of relatively low density, and the fishes must be positive to currents, or they will be swept from the stream. Ability to live in fresh water is correlated at this time with a high metabolic rate. As time goes by, however, the rate of reäction becomes gradually lower, until we find the fishes either becoming actively negative or at least indifferent to currents, and they are swept or swim into the ocean. They now live for some time in alkaline water, and are able to withstand its much higher density. The equilibrium between the environment and the organism is again disturbed after a time, however, and we find the fishes once more selecting the fresh water at another period of high metabolic rate, *i.e.*, with the maturing of the sex glands. From this it would seem entirely possible that fishes which are normally fresh-water forms might be temporarily transformed into salt-water forms by regulating—that is, lowering—the rate of metabolism."

CORRESPONDENCE.

THE FOSSIL FUNGI.

To the Editors of "KNOWLEDGE."

SIRS,—May I be permitted to correct an error which I made in my article on the "Fossil Fungi"? I stated that the fossil fungus which I had found in the Jurassic rocks of Lincolnshire and named *Phycomycites Frodinghamii* was the first fossil fungus which had been found in the Secondary rocks. In writing the latter part of the article, through a sheer temporary mental aberration, I had assigned the Cretaceous rocks to the Tertiary instead of to the Secondary period, with the result that a very stupid mistake was made. The nature of the mistake will be obvious when it is recollected that in the same article I described a fungus from the Cretaceous rocks, and was therefore not writing from ignorance of the fact that such fungi had been discovered. In the same article also I gave a table of classification of the main geological periods in which the Cretaceous rocks were assigned to their proper place. I should like to point out, however, that the mistake was not one in which first principles were involved; and if, when this portion of the article is read, the term "Jurassic rocks" be substituted for the more extensive "Secondary rocks" the damage done may be to some extent repaired. I must at the same time apologise for the necessity of these "repairs."

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THE ROYAL TECHNICAL COLLEGE,
GLASGOW.

SIRS,—While I welcome the entry of a specialist in modern fungology into the fields of palaeobotanical research, I reluctantly recognise several misstatements in the paper by Dr. Ellis in your current number. In the interests of scientific accuracy one at least of these statements cannot be allowed to pass into general currency.

Dr. Ellis says: "With regard to the Secondary rocks, no fossil fungi are known, with the exception of the one described below." This statement is repeated several times, and of his own fungus he says "it is the sole representative of the Secondary rocks." Now in the course of monographing a number of fossil plants from the Secondary rocks for the British Museum I have brought together and re-published, with descriptions and figures taken from various authorities, no fewer than nine species of fungi from the Cretaceous (Secondary) rocks of various parts of the world (see "Catalogue of the Mesozoic Plants" in the British Museum, Part V, "The Cretaceous Flora," Part I, 1913). One of the plants therein included and originally described by Suzuki includes a most beautiful perithecium showing its detailed structures in microscopic section.

Possibly Dr. Ellis does not know this work, but on the very same page on which he states that no Secondary fungi are known he refers to and figures a fungus discovered by me, and described by Stopes and Fujii in *The Phil. Trans. Roy. Soc.*, 1910. This *is* a Secondary fungus; and not only is it clearly stated in our paper that the plants described are from the Secondary rocks, but the very title of the paper is "Studies . . . of Cretaceous Plants"; yet Dr. Ellis speaks of our fungus as Tertiary.

I hope this correction will not discourage Dr. Ellis's efforts to master the fossil fungi, because no fungologist has hitherto dealt with them, and much interesting research on them wants doing. But it must not be forgotten that palaeobotany is a science for which a definite training is needed, and it is seldom sufficient to know recent plants in order to achieve results of value in palaeontology.

M. C. STOPES,
Lecturer in Palaeobotany,
University College, London.

THE GEGENSCHEIN.

To the Editors of " KNOWLEDGE."

SIRS,—As no remarks have been made on Mr. Badgley's letter on page 359 of your December issue, may I be allowed to point out that the reason why the Gegenschein is nearly, or quite, invisible in any part of the world in June and December is obviously because at those times its feeble light is overpowered by the greater light of the Milky Way ?

Is there any ground for the statement that it is best seen in hazy weather ? I should doubt its being visible at all if there were much haze.

T. W. BACKHOUSE.

WEST HENDON HOUSE,
SUNDERLAND.

"THE FIRST MEN ON THE MOON."

To the Editors of " KNOWLEDGE."

SIRS,—Points occur in Mr. H. G. Wells's very entertaining book, "The First Men on the Moon," which, in my opinion, form very interesting food for discussion. Criticisms other than very superficial of the science of such books as these do not, in my opinion, detract from their worth, which should be judged on other lines.

On the theory that gravity is due to waves a substance opaque to it (like Mr. H. G. Wells's "cavorite") is a theoretical possibility, but its properties are, I hope to show, other than those deduced for it by Mr. H. G. Wells and acquiesced in by Mr. Ling in his article on the subject in the February issue of your journal.

Mr. Wells's adventurers left the Earth by the following means. A glass sphere was surrounded by blinds painted with cavorite. These blinds were so adjustable that the sphere might be entirely encompassed or open in any degree and in any part to the influence of gravity. According to Mr. Wells, such a sphere would be free to leave the Earth when entirely surrounded by cavorite. This I hold to be incorrect. In the first place, it would violate the law of the conservation of energy, on which the whole of modern science rests. It would be a means of creating potential energy out of nothing. A machine could be made utilising cavorite, by means of which an inexhaustible supply of energy could be obtained, with practically no expenditure. A heavy load, completely surrounded by an adjustable covering of cavorite, is allowed to rise. On reaching a certain altitude it is automatically uncovered and falls. During its fall it could be made to do work. On reaching a low altitude it is automatically recoated with cavorite and rises, and so on *ad infinitum*. There must, therefore, be some error in Mr. Wells's deductions of the properties of cavorite.

Energy from waves is only released by stopping or partially stopping them. It follows that substances greatly affected by waves are opaque to them. When waves do work they are destroyed, and they cannot be destroyed without their energy being released. Cavorite, being opaque to gravity, would therefore be greatly affected by it. It would, in fact, be by far the heaviest substance known. The most delicate experiments have been unable to detect the slightest diminution in the force of gravity by any substance, however heavy. A film of cavorite, however thin, if it only diminished the force of gravity, must be heavier than any body with which we can experiment.

What has hitherto been overlooked, then, is the weight of cavorite itself, which, as we have seen, must be a large factor.

The only way in which it would be possible to leave the Earth by means of cavorite would be to cover half the Earth therewith. This, however, is a practical absurdity, so we must look elsewhere for possibilities of extra-mundane travel.

I know of only one way in which the problem could be solved, and that is by attaining a velocity of more than 6·9 miles a second. It would be best to travel in the gun (using the recoil), and not the projectile. It would then be possible to carry several rounds by the subsequent firing, of which it would be possible to alter one's course and velocity in space at will, and eventually to return to the Earth.

J. E. MAXWELL.

ROYAL ASTRONOMICAL SOCIETY,
BURLINGTON HOUSE, W.

REVIEWS.

ASTRONOMY.

Is Venus Inhabited ?—By C. E. HOUSDEN. 39 pages. 7¼-in. × 5-in. (Longmans, Green & Co. Price 1/6 net.)

The author of this little brochure has already brought out a larger work, "The Riddle of Mars, the Planet," in which he expresses his firm belief in the truth of Professor Lowell's theory that the canals of that planet are regions of fertility produced by artificial irrigation, the water being conveyed from the polar caps in a series of gigantic conduits. He examines the amount of horse-power that would be required for this purpose, and concludes that the amount found is not beyond the limits of probability. He now turns to our other neighbour, Venus. Here, too, he bases his work on the results that Professor Lowell has announced. These are : (1) That Venus rotates in two hundred and twenty-five days, so that one face is always turned towards the Sun ; (2) that there is a series of spoke-like markings, giving the sunward hemisphere the appearance of a cart-wheel. It has generally been considered that a rotation period of two hundred and twenty-five days would imply the transference of all moisture to the dark hemisphere, where it would be permanently locked up in the forms of ice and snow ; while the sunward hemisphere would be a parched desert, uninhabitable by any forms of life familiar to us. Mr. Housden suggests a way of escape from this conclusion. He imagines the existence of some high mountains near the terminator, which intercept the moisture, forming glaciers on the slopes. These would descend by gravity back to the edges of the bright hemisphere. The presence of intelligent inhabitants is postulated in these portions of the day hemisphere where the Sun is not very high. Lowell's spokes are supposed to indicate conduits, along which the water resulting from the melting of the glaciers is pumped by the inhabitants. He states that the horse-power required for this purpose would be much less than that in daily use on Earth. He explains in this way the fact that observation appears to indicate the presence of a good deal of cloud above the day hemisphere of the planet, which is difficult to reconcile with the assumed rotation in two hundred and twenty-five days, except on the hypothesis that the water is brought back artificially from the dark side. But it needs to be remembered that the reality of the spoke-like markings is still a matter of controversy. It is excessively difficult to detect any markings on Venus, and there is great difference of opinion as to the nature of those that have been seen. Thus we must regard Mr. Housden's ingenious theory as very highly speculative. It may be recalled that our two neighbour planets seem to be the only worlds in the solar system on which life, as we know it, could exist. Mercury and the Moon, presumably also the other satellites, are excluded by the absence of atmosphere ; the giant planets (and still more the Sun) by the high temperature, of which the evidence is practically conclusive.

A. C. D. CROMMELIN.

XUM

PHOTO-MICROGRAPHY.

The Practical Principles of Plain Photo-micrography.—By GEORGE WEST. 146 pages. 8 plates. 5 figures. 10½-in. × 7-in.

(University College, Dundee: George West. Price 4/6 net.)

This book is written by a man who knows what he is talking about, and who can make excellent photo-micrographs, as will be seen from an examination of two of his illustrations (see Figures 113 and 114), which he has been so kind as to lend to us. All the instructions are brief and to the point. No suggestion is made which involves unnecessary expense. One chapter deals with the use of a landscape camera for taking photo-micrographs. More important still is the description of the author's arrangement for doing the same thing without a camera. Some of our most successful photographers with the microscope do their work in a dark-room, and use no dark slides. Mr. George West tells exactly what he does and explains the many advantages of his method. We will not describe this in detail, as we advise all beginners in photo-micrography to get Mr. West's book, but we will say this, that the microscope and the illuminant are in a special chamber, from which the eyepiece of the former protrudes into the dark-room and the image is received upon a screen. The dialogue between "Old Surefoot" and "Young Castlebuilder" on the making of a photo-micrograph is also very much to the point. With regard to the illustrations, they are carefully described, and a table is given showing just how the negatives were made. We may add that the book also includes a chapter on special methods of illumination, a list of photographic chemicals, and a number of photographic formulae. As an appendix, the author prints an open letter to diatomists with regard to (1) a publication on the Diatomaceae of Scotland, which he is preparing; (2) a Genus Index, which would cost twenty persons two shillings each; (3) a Species Index, which would cost twenty persons five shillings each; (4) a Bibliography of the Diatomaceae, which could be produced if forty or fifty subscribers would offer twenty shillings each, or double that number ten shillings each.

W. M. W.

PHYSICS.

The Universe and the Atom: The Ether Constitution, Creation, and Structure of Atoms, Gravitation, and Electricity kinetically explained.—By MARION ERWIN, C.E.

314 pages. 2 plates and 58 figures in text. 8-in. × 5½-in.

(Constable & Company. Price 8/6 net.)

"Each of the stars, like our Sun, is radiating light-waves in every direction through space, and, at infinite distances from their sources, all rays from neighbouring sources, coming into any finite field, must proceed in parallel lines, and become by composition and diminution of amplitude invisible force rays." These "organise the ether structure in systems of equilateral triangles arranged in planes." The explanation of the maintenance of the heat of the Sun "is very simple. The Sun is continuously fed with energy from the radiations proceeding to it from all the stars in infinity." "The process is exactly similar to what takes place when invisible electric waves are brought over a wire into an incandescent electric-light bulb." By assuming that the velocity of the propagation of light is connected with the formula, giving the velocity of propagation of gravitational waves on deep water, the author is able "to actually derive Balmer's formula." By means of the systems of equilateral triangles he also calculates the mass of the electron and the atomic weights, explains gravitation, and generally clears up many physical problems to his complete satisfaction.

It is the duty of a reviewer to state plainly what he thinks of a book, and my view of this one is that it is worthless.

J. H. V.

Colour: A Handbook of the Theory of Colour.—By G. H. HURST. Second edition (revised). 160 pages. 11 coloured plates. 72 illustrations and diagrams. 8-in. × 5½-in.

(Scott, Greenwood & Son. Price 7/6 net.)

The problems connected with colour phenomena are difficult and numerous. Mr. Hurst's book sets forth clearly the explanations of the theory in language that is as simple as is possible in dealing with so difficult a subject.

The work, therefore, will prove of particular value to the student and to all those who have to deal with the matching and mixing of colour. The dyer, colour printer, pigment maker, will find much information that will assist them in dealing with their many perplexities.

The colour plates are striking, and illustrate well combinations and contrast; but it must be pointed out that the one showing absorption spectra is greatly idealised. The student will receive a rude shock when he first examines an absorption spectrum, if his ideas of what absorption spectra are like are derived from a study of this plate.

The illustrations and diagrams are, on the whole, clear, and serve to illustrate the text quite satisfactorily.

J. P. M.

Experimental Physics: A Textbook of Mechanics, Heat, Sound, and Light.—By HAROLD A. WILSON, M.A., D.Sc., F.R.S. 405 pages. 75 illustrations. 8½-in. × 5½-in.

(Cambridge University Press. Price 10/- net.)

This is an excellent textbook by an experienced teacher, who is also a well-known authority on several branches of physics. The treatise is distinctly experimental in treatment; the mathematics employed is of an elementary character. After an introduction on mechanics (one hundred and thirty-two pages), heat and the kinetic theory of gases occupy eighty-nine pages. Wave-motion and sound follow (seventy-two pages), and this leaves one hundred and eight pages for light. Both the geometrical and the wave methods of treatment are used in this section, and illustrative experiments with the optical disc are frequently used. The signs of the focal lengths of lenses are those used in the optical trade and in advanced treatises, so that if a student becomes familiar with them from this book he will have nothing to unlearn if he pursues the subject further on its practical or theoretical side.

References are given to sources of information where the reader can continue his studies more deeply. These references are to books rather than to original papers, a choice which the author has wisely made in view of the character of the readers to whom the book is intended to appeal. The work is well written, well illustrated, and well got up.

J. H. V.

NOTICES.

SECOND-HAND PHOTOGRAPHIC APPARATUS.—Mr. C. Baker's catalogue of second-hand photographic apparatus has reached us, and contains, as usual, details of useful cameras, lenses, and sundries, filling more than forty pages.

IMPERIAL INSTITUTE.—The control of the Imperial Institute will, by the new Act which has recently passed through both Houses of Parliament, rest with the Colonial Office. Details of the change are given in the current number of "The Bulletin of the Imperial Institute."